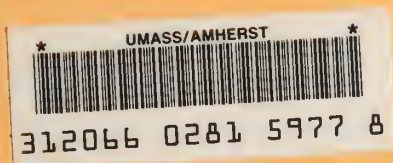


MASS. MA 2.103: 991/995



**LEAD AT WORK:
ELEVATED BLOOD LEAD LEVELS
IN MASSACHUSETTS WORKERS
APRIL 1991 – DECEMBER 1995**

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Lead At Work: Elevated Blood Lead Levels In Massachusetts Workers

April 1991 - December 1995

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April 1998

Acknowledgments

The Occupational Lead Registry is a collaborative effort of the Massachusetts Department of Labor and Workforce Development, Division of Occupational Safety (DOS) and the Massachusetts Department of Public Health (DPH). The Registry, located within the DOS, is responsible for collecting laboratory reports of elevated blood lead levels in adults and conducting case follow-up. The Occupational Health Surveillance Program, DPH, provides medical consultation to the Registry and is responsible for the analysis of Registry data.

Preparation of this report could not have proceeded without the diligence of many individuals. From the Division of Occupational Safety, we gratefully acknowledge the contributions of Kathleen Estridge, Esmirna Soto, and the inspector and industrial hygiene staff, who are responsible for case follow-up. From the Bureau of Health Statistics, Research and Evaluation, DPH, we thank Skip Atkins, M.D., the Registry's medical consultant and Mary Anne Burgoyne, Research Assistant for the Occupational Health Surveillance Program.

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Executive Summary

Lead poisoning, the oldest recognized occupational disease, remains a danger for workers in many industries today. In 1991, Massachusetts established an Occupational Lead Registry to systematically identify workers and workplaces with overexposure to lead in order to target and evaluate prevention efforts (Chapter 200 of the Acts of 1990). Lead Registry regulations require Massachusetts laboratories performing blood lead tests to report blood lead levels of 15 micrograms of lead per deciliter (mcg/dl) of blood or greater in individuals age 15 or older to the Massachusetts Department of Labor and Workforce Development, Division of Occupational Safety. The Registry attempts to conduct follow-up of all persons with blood lead levels of 40 mcg/dl or greater in order to obtain information about a variety of subjects, including source of exposure (occupational or non-occupational), health and safety training and participation in blood lead monitoring programs. This report describes Registry activities and presents the major findings from its first five years of operation.

In Healthy People 2000: National Health Promotion and Disease Prevention Objectives, the federal government set as a goal the elimination of exposures which result in workers having blood lead levels greater than 25 mcg/dl. The information collected by the Massachusetts Occupational Lead Registry indicates that significant steps remain to be taken to achieve this goal. During the period covered by this report (April 1991 - December 1995), the Registry received almost 6,000 reports of blood lead levels of 25 mcg/dl or greater for about 2,600 individuals. Six-hundred sixty-four cases (26%) had at least one blood lead level of 40 mcg/dl or greater, the level at which current federal and state regulations require increased medical surveillance; 266 (10%) had a blood lead level of 50 mcg/dl or greater, a level which may require medical treatment and should trigger immediate removal of the individual from further exposure, under the Occupational Safety and Health Administration (OSHA) Lead Standard for Construction and the Massachusetts deleading regulations. Exposure information was obtained for 646 cases with blood lead levels of 40 mcg/dl or greater. The great majority (85%, n=547) were occupationally exposed to lead.

Construction

Over two-thirds of the workers (70%, n = 380) with blood lead levels of 40 mcg/dl or greater were employed in the construction industry, primarily as deleaders (31%, n = 172) and bridge and house painters (29%, n = 161). Construction workers constituted an even greater proportion (80%, n = 80) of those with the highest blood lead levels. Painters alone accounted for 46% (n = 46) of those with blood lead levels of 60 mcg/dl or greater. The very highest blood lead levels observed were among house painters.

These findings underscore the potential for overexposure to lead in construction work and the need for increased prevention efforts. The new OSHA Standard for Lead Exposure in the Construction Industry is an important step forward. Strict enforcement of this standard, as well as of state deleading regulations, is essential to reduce overexposure to lead among construction workers. Recent state initiatives to include health and safety requirements in contracts for bridge painting projects provide added protection for workers in this industry. The house painting industry poses a special challenge for prevention given the large number of small firms in this

industry and the short-term nature of most house painting jobs. Strategies must continue to be developed to provide house painters with information about controlling lead exposures and the importance of regular blood lead monitoring. Finally, efforts to evaluate alternative lead removal and control measures for use in the construction industry should also continue.

Manufacturing

Despite the promulgation of the OSHA Lead Standard in 1978, overexposure to lead continues in manufacturing industries. Of workers with blood lead levels of 40 mcg/dl or greater, 23% worked in manufacturing industries, primarily foundries, smelters, and plastics and glass products manufacturers. Increased enforcement, education, and technical assistance are necessary to address the ongoing problems of overexposure in lead-using manufacturing industries.

Monitoring, notification and training

Almost all deleaders contacted reported that they participated in employer-sponsored blood lead monitoring programs and were trained about the hazards of lead, reflecting the impact of state licensing regulations for deleading contractors. Many workers in other industries reported that they had neither received training about lead hazards nor had they participated in blood lead monitoring programs.

At the time of interview, a number of workers reported that they had not been informed about their elevated blood lead level by either their health care provider or their employer. This information indicates that some physicians providing services to employers do not fully understand their responsibilities under the OSHA Lead Standards. Physicians providing these services need to work closely with employers to ensure adequate notification and medical management of workers overexposed to lead.

Hispanic workers

Hispanic workers are disproportionately represented in the Registry, underscoring the need to provide linguistically and culturally appropriate health and safety services and education programs, and to better understand the employment patterns which place Hispanic workers at increased risk. The overrepresentation of Hispanic workers has also been reported by lead registries in other states, including California, Texas, and New Jersey, and is consistent with evidence that minority workers generally are over-represented in high-risk jobs.

Non-occupational exposures

Exposure to lead at firing ranges and during home renovation activities accounted for a significant number of registrants (74) with blood lead levels of 40 mcg/dl or greater, underscoring the fact that non-occupational activities can also place adults at risk for lead overexposure. Persons participating in these and other non-occupational activities (e.g. crafts) with potential for exposure to lead need to be informed about the risks involved both to themselves and other family members, as well as about methods of preventing overexposure. Efforts, at both the federal and state government levels, have been made to address this problem. However, much more remains to be done.

Limitations

The most significant limitation of the data in this report is that a large, but unknown percentage of workers who work in certain industries, particularly those consisting primarily of small establishments (e.g. automotive radiator repair), are known to have significant exposures to lead, but few or no cases have been reported to the Registry. These workers are unlikely to receive regular blood lead testing, even though in most cases, such testing is mandated by the OSHA Lead Standard. Furthermore, the Lead Registry does not receive all blood lead reports (and does not obtain industry information for blood lead levels below 40 mcg/dl). Without this information, it is not possible to draw definitive conclusions about the relative risk of lead poisoning by industry or patterns in lead poisoning over time.

Conclusion

Overexposure to lead on the job continues to be a significant problem for many Massachusetts workers. Industry, labor, the medical community, and government each have a role to play in the effort to control and ultimately prevail over this age-old problem. The Occupational Lead Registry will continue to play an essential role in this effort by generating the information necessary to target and evaluate prevention efforts.

Introduction

Inhaled or ingested lead causes both acute and chronic health problems in children and adults alike. The workplace is the primary source of adult exposure, and workers in many industries are exposed to potentially dangerous levels of lead. Lead is used in the manufacture of many products, such as batteries and plastic goods. Lead is also found in numerous work processes, including smelting, soldering, and welding. Lead paint is found in most older residences where it poses a health hazard not only for the children who live in these homes but also for workers removing the paint. Lead paint has also been used extensively on exterior structures, placing bridge painters and other heavy construction workers at risk of lead poisoning. The National Institute for Occupational Safety and Health (NIOSH) estimates that as many as 827,000 workers in the United States are potentially exposed to lead on the job.

Lead can also effect the children of exposed workers. Many studies have shown that lead dust can collect on work clothes, and when those clothes are worn home, the lead can contaminate workers' cars and homes. Young children can then be poisoned by the lead-contaminated dust.

Since April 1991 clinical laboratories in Massachusetts have been required to report blood lead test results of 15 micrograms of lead per deciliter of blood (mcg/dl) or greater in individuals age 15 or older to the Massachusetts Occupational Lead Poisoning Registry.¹ The Registry is located within the Division of Occupational Safety (DOS) of the Massachusetts Department of Labor and Workforce Development. Massachusetts is one of over 30 states nationwide with an occupational lead registry, and participates in a national lead surveillance program.

The purpose of the Registry is to reduce the incidence of lead poisoning among Massachusetts workers and their families by identifying workers and workplaces with overexposure to lead. This information is essential for targeting technical assistance and educational and regulatory activities to prevent occupational lead poisoning in Massachusetts. This report presents the major findings of the Occupational Lead Poisoning Registry from April 1991 to December 1995.

Lead-Poisoned House Painters

DANVERS- For years, Mr. H. ignored a crippling cough, headaches, erratic mood swings, sleeplessness, and a diminished sex drive. But a relentless case of stomach cramps prompted him to seek medical help where doctors discovered his blood was contaminated with lead.

"At first the symptoms didn't faze me too much," said Mr. H., a house painter. "But I didn't know what was going on with the stomach pain."

Mr. H., 47, gave up a job as an aerospace machinist in 1985 because he grew tired of working indoors. That same year, he went to work for a small painting company.

"We removed the paint with a seven-inch disk grinder and the lead was flying all over the place," Mr. H. recalled. "During summer we wore shorts and no shirts."

At the time, Mr. H. said, no one on the crew knew the dangers of lead paint. For nearly nine years, his only protection was a paper dust mask, ineffective against lead dust.

Boston Globe, Monday, May 1, 1995

Health Effects of Lead

Lead can enter the body in several ways. In the occupational setting, lead usually is absorbed into the body by inhalation of lead dust or fumes. Lead can also be ingested, for example, when workers eat their lunches in contaminated workplaces. Organic lead, such as tetraethyl lead, can be absorbed through the skin. Lead accumulates in the blood, bones, and organs such as the brain and kidneys, and is eliminated from the body slowly. Even small doses over time can cause lead poisoning.

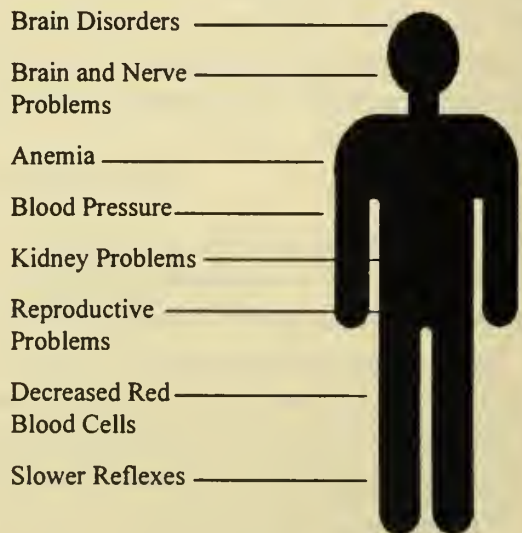
Cumulative exposure to lead can cause permanent damage of the nerves of the hands and feet, brain damage, kidney failure and anemia. It has also been associated with high blood pressure. Lead is known to affect the reproductive systems of both men and women, causing infertility and adverse pregnancy outcomes such as stillbirths and miscarriages. Lead also poses a risk to the developing fetus. According to the Centers for Disease Control and Prevention, children born with blood lead levels above 10 mcg/dl may have reduced learning ability.

Most physicians consider blood lead levels in adults exceeding 40 mcg/dl to be clinically significant (the background level in the general population of the U.S. is approximately 4 mcg/dl).³ However, recent research indicates that lead can be harmful at levels lower than those previously thought to be safe. Blood lead levels between 15 and 40 mcg/dl have been found to have subtle effects on the nervous system, red blood cells and kidneys, as well as adverse reproductive effects.

Symptoms of Lead Poisoning

- Fatigue
- Irritability/anxiety
- Uneasy stomach
- Aches or pains in stomach
- Nausea
- Constipation
- Poor appetite
- Weight loss
- Headache
- Loss of memory
- Muscle and joint pains
- Weak wrists or ankles
- Sleeplessness
- Metallic taste

Health Effects of Lead in Adults



Source: Adapted from the U.S. Environmental Protection Agency (EPA). Air Quality Criteria for Lead. Research Triangle Park, NC:EPA, 1986.

Lead Registry Activities

All reports of blood lead levels of 25 mcg/dl or greater are entered into a computerized database and subsequently analyzed. The Lead Registry conducts follow-up of elevated blood lead levels, including worker and physician interviews and education, workplace investigations, and employer education and technical assistance. The degree of follow-up depends on the blood lead level and, because of resource limitations, is currently initiated for individuals with blood lead levels of 40 mcg/dl or greater.

At blood lead levels of 40 mcg/dl, or greater, Registry staff interview the case to find out more about the source of exposure. Educational materials are sent to both the registrant and the physician who ordered the blood test. If there is a child under the age of six at home, the Registry sends information on free blood lead testing programs. In addition, a DOS industrial hygienist or inspector conducts a worksite investigation if deemed appropriate. At blood lead levels of 60 mcg/dl or above, the Registry medical consultant contacts the physician to provide information on treatment of lead poisoning and OSHA requirements for medical monitoring of lead-exposed workers.

In addition, anonymous data are also forwarded to NIOSH which compiles data from occupational lead registries in approximately 25 states. These data, published quarterly in *Morbidity and Morbidity Weekly Review*, are beginning to provide information at the national level about the extent of occupational lead exposure. In 1995, NIOSH received over 24,000 reports of blood lead levels of 25 mcg/dl or greater.

In addition to the above ongoing follow-up activities, the Registry has also undertaken a number of special projects to educate workers, employers, and physicians about occupational lead poisoning and to assist employers in reducing exposure. These include:

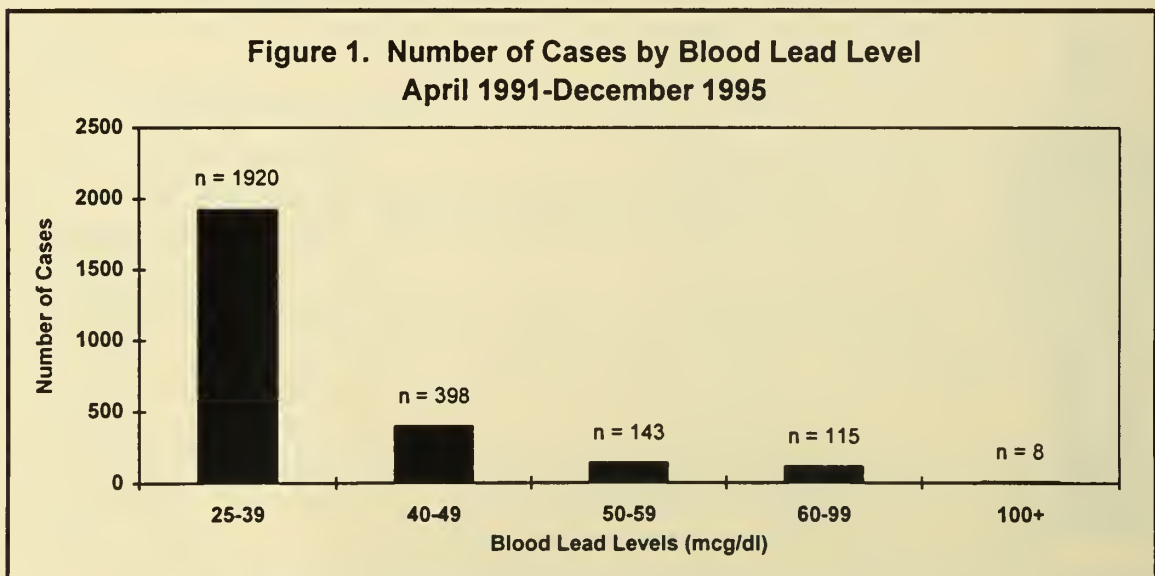
- publishing booklets on lead exposure in general industry (in English and Spanish) and construction (in English, Spanish & Greek)
- training inspectors from the Massachusetts Highway Department, who are responsible for overseeing painting and renovation work on the state's bridges, about the hazards and control of lead paint removal
- publishing articles on preventing lead exposure in house painting in the newsletters of contractor trade associations
- surveying lead-using industries regarding their air monitoring and medical monitoring practices
- making presentations to public health organizations and occupational health and safety professionals regarding the Lead Registry and its findings
- publishing a booklet on controlling lead paint hazards in schools
- conducting a public education campaign on adult lead poisoning
- publishing educational materials for physicians

Findings

Blood Lead Levels

Between 1991 and 1995, the Registry received 5993 reports of blood lead levels at or exceeding 25 micrograms per deciliter (mcg/dl) on 2457 different persons. A total of 2584 cases were identified during the study period. A “case” is defined by the National Institute for Occupational Safety and Health (NIOSH) as *an individual with a reported blood lead level greater than 25 mcg/dl for whom there were no reports of elevated blood lead levels during the previous calendar year.*² Using the highest blood lead level (peak blood lead level) reported for each case, cases in the Registry were distributed as follows (See Figure 1):

- 664 cases (26%) had blood lead levels of 40 mcg/dl or greater, a level which the Occupational Safety and Health Administration (OSHA) considers elevated for regulatory purposes;
- 266 cases (10%) had blood lead levels of 50 mcg/dl or greater;
- 123 (5%) cases had blood lead levels of 60 mcg/dl or greater;
- 8 cases had blood lead levels of 100 mcg/dl or greater. Three of these individuals had blood lead levels between 130 and 135 mcg/dl and occupational exposures (all three were house painters). Of the remaining five cases, three were exposed through do-it-yourself renovation work, and two had undetermined, but most likely non-occupational sources of exposure.



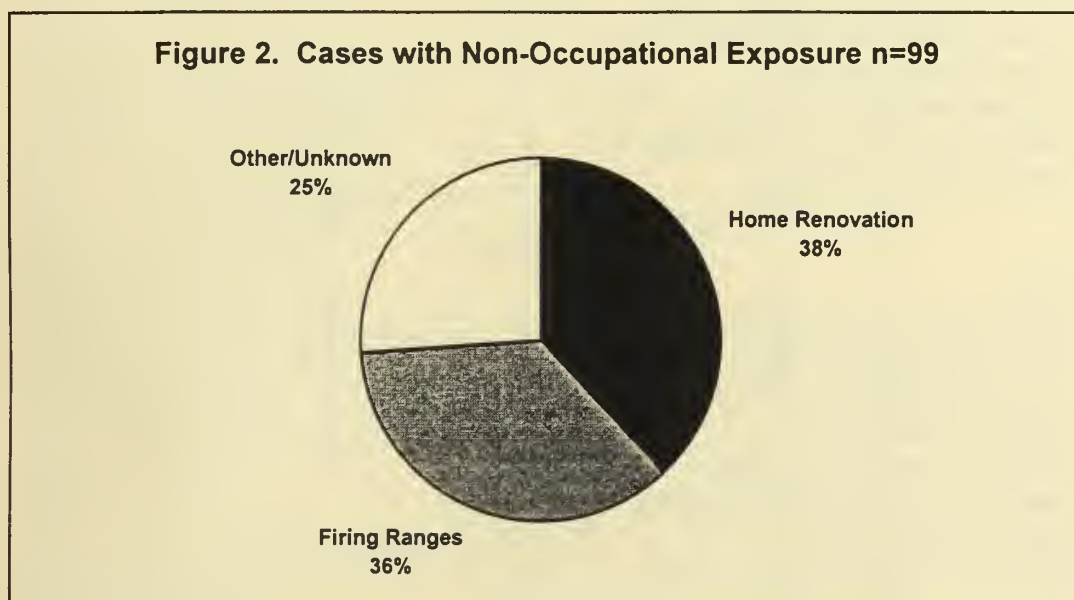
Age and Gender

Over 96% of the cases were male.

The median age of cases was 36 years. Ages ranged from 15 to 99. The overall distribution by age was similar to that of the working population of the state.

Occupational Characteristics

Attempts were made to obtain more extensive information for the 664 cases with peak blood lead levels of 40 mcg/dl or greater by contacting each case and the health care provider who ordered the test. A source of exposure was determined for 646 cases; of these 547(85%) were occupational. Of the 99 cases determined to have non-occupational exposure, 38 were exposed while renovating or repairing their own homes and 36 were exposed at firing ranges.



Cases with occupational exposures were identified in 61 industries and at least 262 separate companies. A complete list of all industries in which cases worked and the number of companies identified in each industry is shown in Table 1.

Table 1. Distribution of Cases and Companies by Peak Blood Lead Levels (40 mcg/dl or greater), by Industry, April 1991 - December 1995, Massachusetts Occupational Lead Registry

SIC code*	Industry	No. of Cases	Blood Lead Level (mcg/dl)		No. of Companies
			40-59	60+	
Construction					
1500	Building and construction, general	1	0	1	1
1521/22	General Contractors - Residential	4	2	2	3
1622	Bridge and Highway Construction	15	13	2	5
1711	Plumbing, heating and air-condition	1	1	0	1
1721	Painting: Bridge	60	50	10	16
	House	101	65	36	64
1731	Electrical Work	1	1	0	1
1751	Carpentry	2	1	1	1
1752	Floor Laying and Other Floor Work	2	1	1	1
1761	Roofing, Siding, and Sheet Metal Work	1	1	0	1
1791	Structural Steel Erection	2	1	1	1
1795	Wrecking and Demolition Work	13	10	3	6
1796	Erection of building equipment, NEC**	2	1	1	1
1799	Special Trades: Deleading	172	151	21	99
	Ornamental Iron Work/Other	3	2	1	1
	subtotals	380	300	80	202
Manufacturing					
2821	Plastics Materials, Synthetic Resins	41	34	7	3
2899	Chemical Preparations, NEC	1	1	0	1
3081	Unsupported Plastics Film and Sheet	2	2	0	1
3089	Plastics products, NEC	3	3	0	1
3229	Pressed and Blown Glass, NEC	6	5	1	1
3231	Glass Products from Purchased Glass	3	3	0	3
3269	Pottery Products, NEC	1	1	0	1
3315	Steel Wiredrawing, Nails and Spikes	4	4	0	2
3321	Gray and Ductile Iron Foundries	5	5	0	1
3334	Primary Production of Aluminum	2	2	0	1
3339	Primary Smelt/Refining Nonferrous	7	5	2	4
3341	Secondary Smelt/Refining Nonferrous	11	9	2	3
3357	Drawing/Insulating Nonferrous Wire	1	1	0	1
3363	Aluminum Die Castings	5	5	0	1
3365	Aluminum Foundries	2	2	0	2
3366	Copper Foundries	4	4	0	1
3443	Fabricated Plate Work	1	0	1	1
3449	Misc. Structural Metal Work	4	4	0	1
3462	Iron and Steel Forgings	1	1	0	1
3469	Metal Stampings, NEC	4	3	1	1
3482	Small Arms Ammunition Mfg.	1	1	0	1
3484	Small Arms Mfg.	3	3	0	2
3544	Special dies, tools, molds	1	1	0	1
3648	Lighting Equipment, NEC	1	1	0	1

Table 1. Distribution of Cases and Companies by Peak Blood Lead Levels (40 mcg/dl or greater), by Industry, April 1991 - December 1995, Massachusetts Occupational Lead Registry

SIC code*	Industry	No. of Cases	Blood Lead Level (mcg/dl)		No. of Companies
			40-59	60+	
3691	Storage Batteries, Mfg.	5	5	0	2
3731	Ship Building and Repairing	3	2	1	2
3823	Indus. Instrum. for Process Variables	1	1	0	1
3914	Silverware and Plated Ware Mfg.	4	4	0	2
3949	Sporting and Athletic Goods Mfg., NEC	1	1	0	1
	subtotals	128	113	15	44
Other Industries					
0910	Commercial fishing	1	1	0	1
4813	Telephone Communications	1	1	0	1
4931	Electric Services	1	1	0	1
4953	Refuse Systems Services	2	2	0	2
5093	Scrap and Waste Materials	8	8	0	1
6513	Operators of apartment buildings	2	1	1	1
6514	Operators of other dwellings	1	1	0	1
6519	Lessors of real property, NEC	5	3	2	3
7381	Detective and Armored Car Services	2	2	0	1
7538	General Automotive Repair	1	1	0	1
7539	Automotive Repair, NEC	6	5	1	6
7991	Physical fitness facilities	1	0	1	1
7999	Amusement and Recreation Services	3	3	0	3
8099	Health Services, NEC	1	1	0	1
8322	Individual and Family Services	1	1	0	1
9199	General Government, NEC	1	1	0	1
9221	Police Protection	1	1	0	1
9711	US Armed Forces	1	1	0	1
	Occupational - unknown industry	1	1	0	-
	Non-occupational	99	77	22	-
	Unknown	17	16	1	-
	subtotals	156	128	28	28
TOTAL		664	541	123	274

* Standard Industrial Classification (SIC) codes are established by the Federal government and are used to classify establishments for statistical purposes by their type of activity.

** Not Elsewhere Classified (NEC)

Construction Workers

- Of 546 cases with blood lead levels of 40 mcg/dl or greater and known industry, 380 (70%) were employed in construction, primarily as deleaders and painters (Figure 3).
 - 172 (31%) worked in the deleading industry.
 - 161 (29%) worked in the painting industry, 60 as bridge painters and 101 as house painters
- Construction workers constituted an even greater majority (80%) of workers with blood lead levels of 60 mcg/dl or higher.
 - Although painters accounted for 29% of cases with blood lead levels of 40 mcg/dl or greater, they comprised 46% (n=46) of those with blood lead levels of 60 mcg/dl or greater. Deleaders accounted for an additional 21% (n=21) of those cases with blood lead levels of 60 mcg/dl or greater.

Figure 3. Blood Lead Levels by Industry (>40mcg/dl)

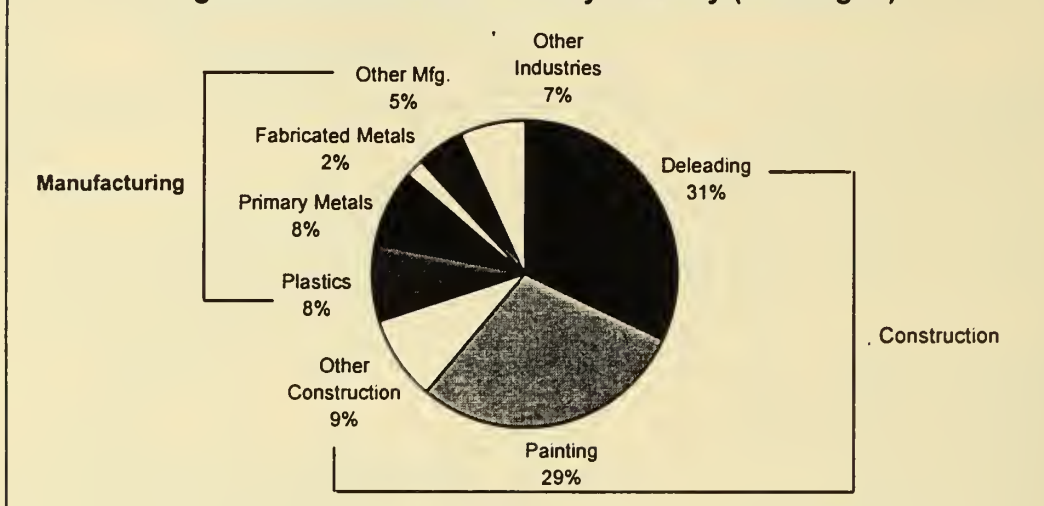
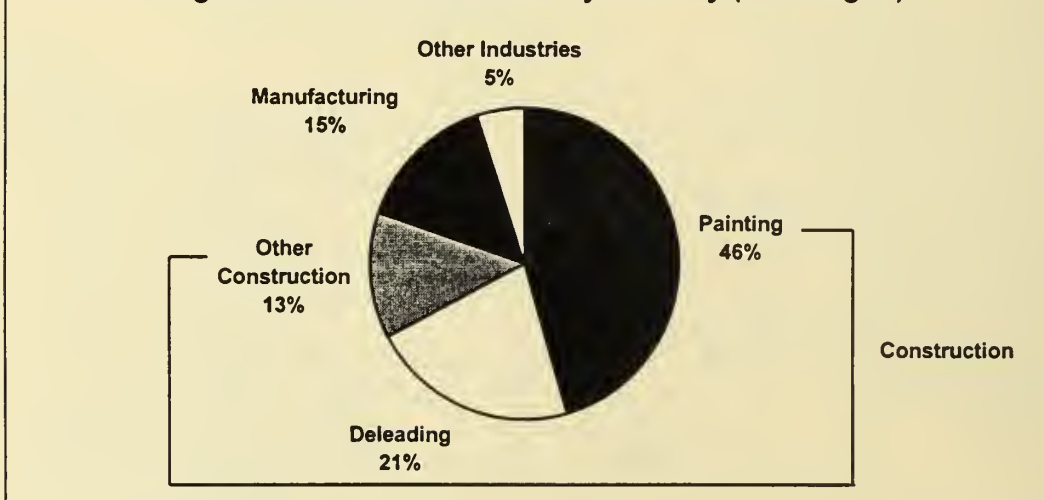


Figure 4. Blood Lead Levels by Industry (>60 mcg/dl)



The proportion of persons in the Massachusetts Lead Registry who worked in construction is substantially higher than in the lead registries in most other states.⁴ While variations in industry composition and the extent of residential deleading activity account for some of the difference, an important contributing factor to the high proportion of construction workers reported to the registry, is the impact of Massachusetts regulations which require blood lead testing of deleaders as a condition of their employer's licensure. In addition, the Massachusetts Highway Department has, since 1994, required blood lead monitoring as a condition of its bridge painting contracts. Without these regulations, many more workers with elevated blood lead levels would certainly have gone undetected, as is probably the case in most other states where such regulations were not in place.

Manufacturing and Other Workers

- 128 (23%) of the 547 cases with known industry and blood lead levels of 40 mcg/dl or greater were employed in manufacturing (Figure 3).
 - 41 (8%) worked in the primary metal industries, including foundries and smelters.
 - 42 (8%) worked in plastics manufacturing.
 - 13 (2%) worked in fabricated metal manufacturing.
- Industries other than manufacturing and construction with 3 or more cases include:
Scrap and Waste Metal Services (n=8), Automotive Repair (primarily auto radiator repair) (n=7), Lessors of Property (n=5), Amusement and Recreation Services (n=3).

Information from Worker Interviews

Registry staff attempted to interview all persons with blood lead levels of 40 mcg/dl or greater who had occupational exposures; interviews were completed with 320 individuals (59%). The main reason for failure to interview was the inability to obtain telephone numbers or addresses of cases through health care providers and the reluctance on the part of the Registry to contact employers for this information without employee permission. Deleaders (50%, n=87) were less likely to be interviewed than painters (65%, n=104) and non-construction workers (59%, n=98).

Some highlights of information obtained from interviews with elevated blood lead levels follow:

Hispanic Workers

⇒Hispanic workers comprised 9% (n=27) of all interview respondents, approximately 4 times the proportion they constitute of the Massachusetts employed population. Most (67%) were employed in non-construction industries.

Medical Testing

⇒Almost all deleaders who responded to an interview reported being tested as part of an employer sponsored medical screening program (97%), while only 44% of “other” construction workers and 35% of painters had their blood lead levels tested as part of an employer-sponsored program. 71% of non-construction workers reported employer-sponsored testing. See Figure 5.

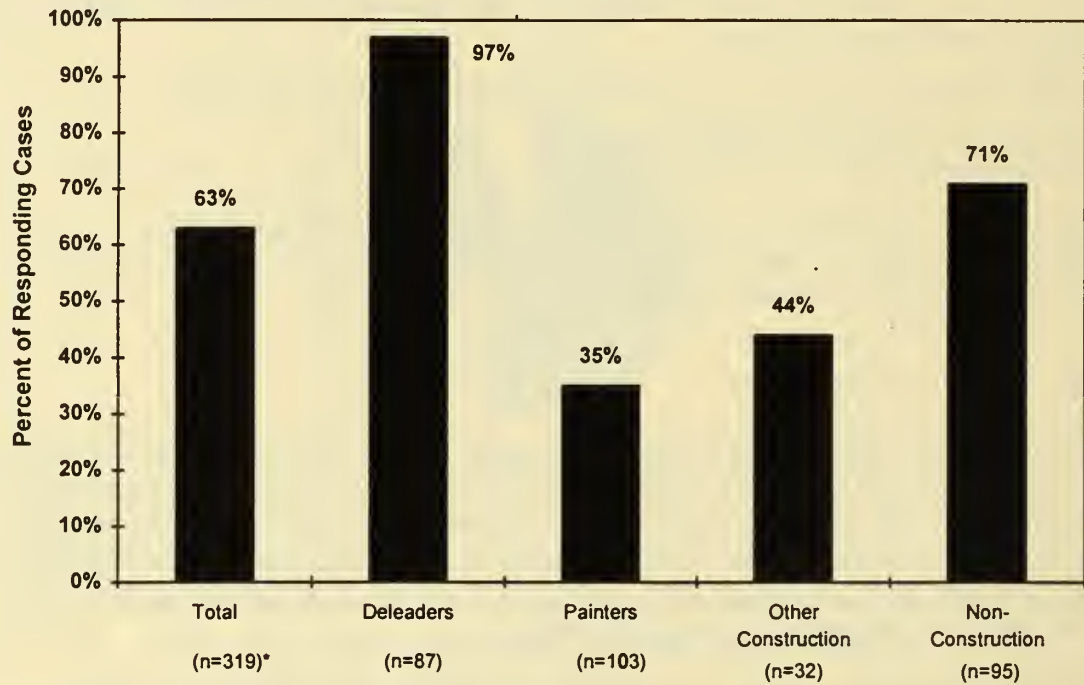
Training

⇒More than one-third (37%) of all those interviewed said they had not received training in the hazards of lead. Virtually all deleaders reported receiving some training. On the other hand, only 41% of other construction workers and 59% of non-construction workers reported any training, as required by the OSHA Lead and Hazard Communication Standards. See Figure 6.

Notification

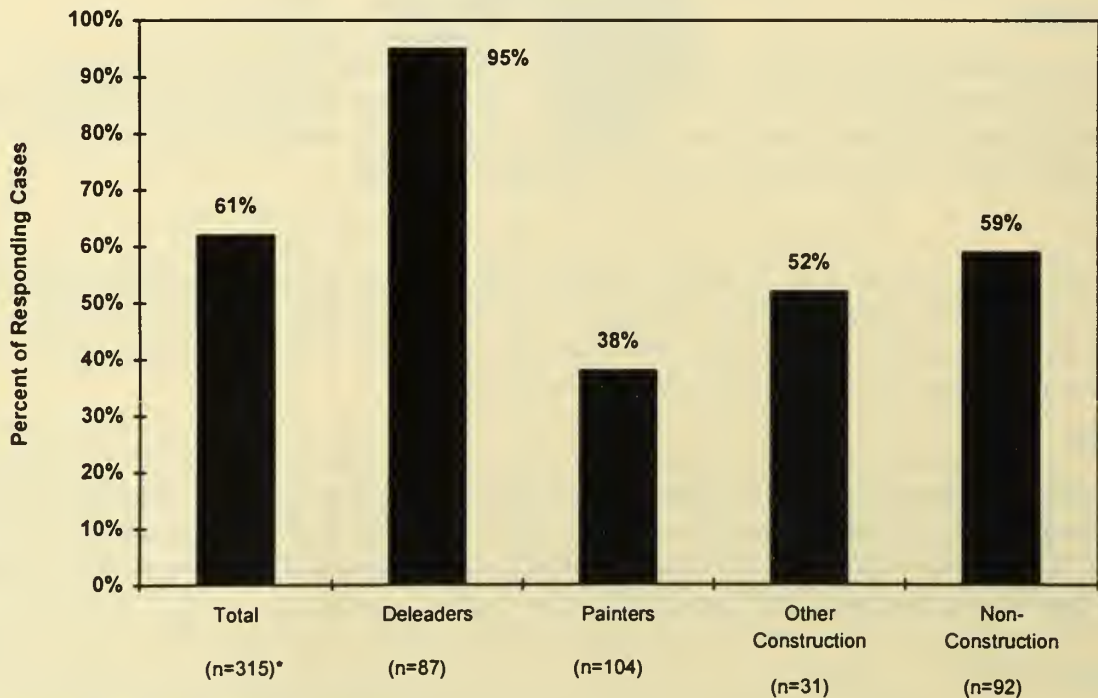
⇒At the time of the interview, 13% of workers with blood lead levels 40 mcg/dl or greater reported that they had not been informed about their elevated blood lead level by their health care provider or employer. Even among workers with blood lead levels 60 mcg/dl or greater, 15% reported that they had not been informed about their elevated blood lead level.

**Figure 5. Self-Reported Participation in Medical Screening
(40 mcg/dl)**



* includes 2 cases with missing SIC information

**Figure 6. Self-Reported Training in the Hazards of Lead
(40 mcg/dl)**



* includes 1 case with missing SIC information

⇒Among those interviewed with blood lead levels of 60 mcg/dl or greater, a level at which medical removal from further exposure is advised or required, 58% said they were still working in conditions which exposed them to lead at the time of the interview.

⇒75% of respondents reported co-workers in the immediate area at risk of exposure.

⇒27% of interviewees reported having a child under the age of six at home; young children may be at risk from lead inadvertently brought home from the job on clothes or in the car. This figure was highest among construction workers not working in the deleading industry, the same group of workers who were the least likely to receive training.

Elevated Blood Lead Levels in Children of Construction Workers

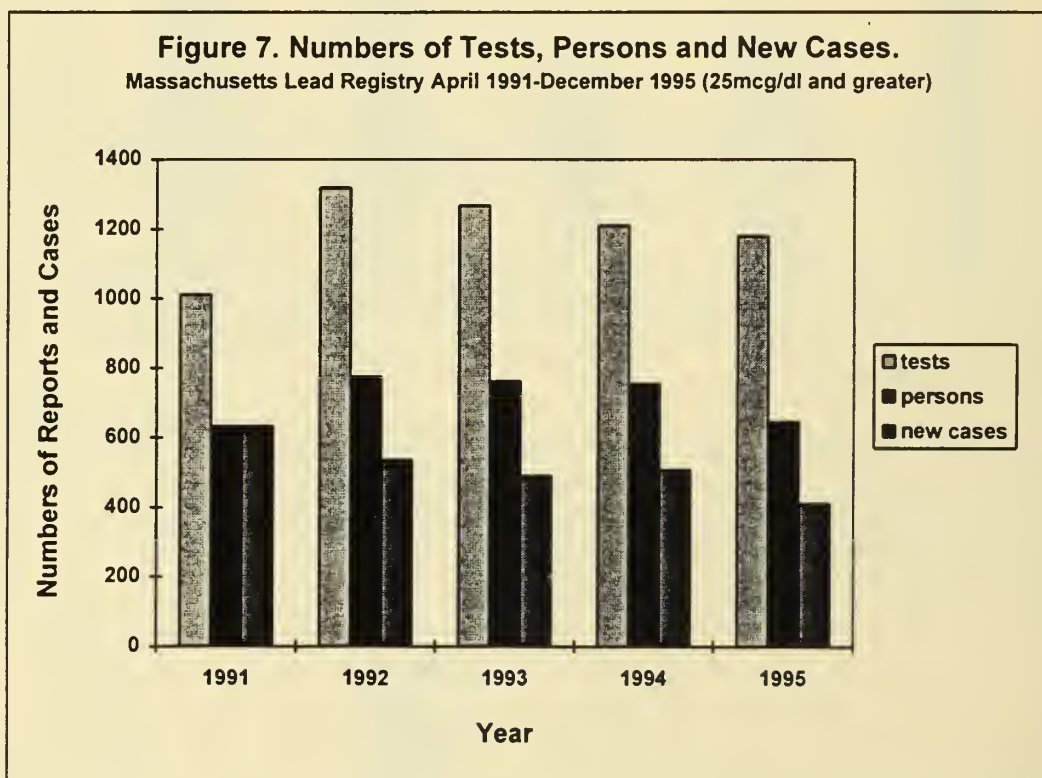
(adapted from: Whelan E, et. al: Elevated Blood Lead Levels in Children of Construction Workers. American Journal of Public Health 1997; 87:1352-1355)

A recent study compared blood lead levels in children of construction workers with those of other children. Twenty-nine construction workers were identified from the New Jersey Adult Blood Lead Epidemiology and Surveillance (ABLES) registry. Eighteen control families were also studied.

Twenty-six percent of workers' children had blood lead levels at or over the U.S. Centers for Disease Control and Prevention action level of 10 mcg/dl, compared with 5% of control children. Dust lead levels were also higher in the automobiles and homes of construction workers than in those of control households. Most workers did not have company laundered work clothes or shower facilities.

Trends in Reporting Over Time

The total number of tests, persons and new cases identified each year has been declining over time (see Figure 7). However, the proportion of cases identified within each blood lead level category (25-39 mcg/dl, 40-49 mcg/dl, 50-59 mcg/dl, 60+ mcg/dl) has remained relatively constant over time. Due to the limitations of the data, it is not possible to draw any definitive conclusions from this trend (see “Limitations” page 18).



An important component of the surveillance system is its ability to identify new workplaces where potentially high exposures to lead occur. Since 1991, among workers with blood lead levels 40 mcg/dl and greater, 262 workplaces have been identified. Since 1992, between 39 and 51 new workplaces have been identified each year.

Workplace Follow-up

The Registry considers workplace follow-up when companies with one or more workers with blood lead levels 50 mcg/dl and greater are identified.* Because the workplaces and circumstances in which workers are exposed to lead differ widely, a variety of follow-up activities are undertaken.

Construction

124 companies in the construction industry had at least one case with a blood lead level of 50 mcg/dl or greater. Follow-up is particularly challenging because in many cases jobs have been completed by the time elevated blood lead levels come to the attention of the Registry. The Registry handles follow-up of construction worksites in a variety of ways:

- Registrants who are employed in **deleading** are referred to the Division of Occupational Safety's (DOS) Asbestos & Lead Program, which has responsibility for inspecting deleading operations.
- To address **bridge painting**, the Registry and other DOS personnel have conducted a number of activities. Initially, DOS responded to individual elevated (50 mcg/dl) blood lead levels with a worksite investigation. Subsequently, the Registry provided a series of trainings on lead hazards to inspectors of the Massachusetts Highway Department (MHD). The Registry also assisted MHD in developing specifications for worker protection from lead paint exposure in its bridge painting contracts. Also, to coordinate worker health and safety activities with other agencies, DOS negotiated and signed a Memorandum of Understanding with OSHA and the MHD to inspect ongoing bridge projects for compliance with federal and state standards.
- **House painting** is particularly difficult to follow up, owing to the small size of most firms and the short-term nature of most jobs. While there were numerous house painters with elevated blood lead levels, in only six instances were there more than one registrant per company. Currently, the Registry, with registrant permission, sends a letter to the company which points out the high blood lead level and discusses possible causes, relevant regulations, and the availability of free consultative services.
- Firms engaged in **other construction work** are handled on a case-by-case basis. For example, a worksite investigation was conducted for one company which was engaged in repairing a fire escape which contained lead-based paint.

Manufacturing and other industries

Outside of the construction sector, there were 25 companies which had at least one case with a blood lead level of 50 mcg/dl or greater. DOS industrial hygienists and inspectors conducted

* In 1995, DOS began investigating companies with one or more workers with blood lead levels 40 mcg/dl and greater.

investigations at 14. Those which were not inspected either had had recent OSHA inspections, involved self-employed individuals, had gone out-of-business, or were judged to be lower priority, given available resources. An additional six investigations were also conducted at companies with multiple registrants with elevated blood lead levels below 50 mcg/dl. Of the twenty companies investigated, foundries and smelters (5), chemical and plastic manufacturers (3) and fabricated metal products (3) were the most common types of companies inspected.

Industrial Hygiene Findings

DOS industrial hygienists and inspectors surveyed conditions at a total of 40 sites based on elevated blood lead results. Investigations revealed a variety of conditions contributing to over-exposure to lead.

- Mechanical ventilation was absent in 40% of the sites evaluated. Although several of those cited involved outdoor work, properly placed fans, blowers, or more sophisticated air cleaning devices can be used during bridge painting and outdoor construction work to reduce worker exposure to inhaled lead.
- Ventilation in several other sites was not consistently maintained or repaired to ensure effective operation.
- Air sampling designed to evaluate potential inhalation exposure had only been conducted in half of the companies. Even fewer had a program of regular air monitoring on a periodic basis.
- Efforts to monitor the health of employees were judged inadequate in half of the sites investigated. While most (85%) companies had provided at least one blood lead test, only about half provided a full medical surveillance program (including comprehensive medical examinations and occupational histories) which could have aided in diagnosis of lead-related illness.
- Respiratory protection was judged to be insufficient in at least half of the companies. Selection of respiratory protection should be based on air monitoring results, which were absent in many companies. Twelve companies failed to offer any respiratory protection, or provided only disposable dust masks which offer inadequate protection against elevated concentrations of airborne lead. Only 15 of the 26 employers who provided respirators were found to have a full respiratory protection program, including policies and practices to ensure that respirators are clean and properly fitted.

Hygiene facilities, particularly showers, were lacking in more than half of the workplaces. Separated eating areas were not available in more than a third of the worksites. Availability of these facilities is important in preventing ingestion of lead on the job, as well as making sure that workers do not carry lead home to family members on their clothing.

* Some of the control measures which may prevent or minimize lead poisoning may not be required by the OSHA lead standards. For example, showers are not required unless airborne lead levels are above the permissible exposure limit (PEL) of 50 mcg/m³.

Discussion

In Healthy People 2000, the federal government set as a goal the elimination of exposures which result in workers having blood lead levels greater than 25 mcg/dl. The information collected by the Occupational Lead Registry indicates that Massachusetts has a long way to go in order to achieve this goal. During its nearly five years of operation, the Registry identified nearly 2600 persons with elevated blood lead levels, the great majority of whom were exposed in the course of their work. Over a quarter had blood lead levels of 40 mcg/dl or greater. The findings presented in this report highlight a number of specific areas where increased efforts to prevent occupational exposure to lead are needed.

Construction

Overexposure to lead continues to be a serious and widespread problem for many workers in the construction industry in Massachusetts. Residential deleaders and bridge and house painters comprise the majority of workers in the Registry with blood lead levels of 40 mcg/dl or greater, and an even greater proportion of those with levels greater than 60 mcg/dl. A substantial proportion of construction workers reported having young children at home. This raises the concern that the lack of proper hygiene facilities and practices at work may be exposing children to lead in their homes. In a recent study in New Jersey (as well as in other research), the blood lead levels of the children of lead-exposed construction workers and the dust lead concentrations in their homes and cars were elevated, compared to a control group. These results clearly underscore the need for increased efforts to reduce the risk of lead poisoning among construction workers.

Effective August 1993, OSHA adopted a Lead Standard for Construction, extending protections to construction workers which other workers have had since 1978.* Among other provisions, it significantly decreases the amount of allowable lead exposure and sets requirements for regular blood lead testing of construction workers.

Deleading

The large number of deleaders in the Registry highlights the potentially hazardous nature of deleading. In addition to the risks posed to workers, high lead levels may also translate into increased risks to occupants. It should be noted that part of the reason why deleaders comprise such a large proportion of cases is because state regulations, which mandate blood lead testing and reporting to DOS as requirements for licensure, make it much more likely that deleaders will in fact be tested. If testing rates were similarly high in other industries, there would undoubtedly be larger numbers of workers in those industries in the Registry.

* In order to be consistent with the new medical removal requirements in the OSHA Lead Standard for Construction, the Massachusetts Division of Occupational Safety amended its deleading regulations, effective April 1994, to lower the blood level requiring removal from further exposure to lead from 60 to 50 mcg/dl.

Both increased awareness of deleading regulations and continuing evaluation of the safety of existing and alternative lead removal and lead control measures (e.g., encapsulation, wet scraping) are important components of a strategy to reduce the hazards of deleading operations.

Bridge painting

The Division of Occupational Safety (DOS), in cooperation with other agencies, began to take a number of steps designed to reduce exposure to lead among workers repairing and maintaining the state's bridges. A memorandum of understanding signed by DOS, OSHA and the Massachusetts Highway Department (MHD) establishes a framework for cooperation among the agencies to identify and inspect bridge painting operations and to protect workers from over-exposure to lead. DOS has also trained MHD inspectors in the recognition of operations which may be generating hazardous levels of lead. MHD, with DOS assistance, has included specific blood lead monitoring and health and safety language in bridge repair contracts. Strict enforcement of these contract provisions, however, is vital to creating and maintaining a "level playing field" for those contractors who are willing to implement measures to protect their employees and the health of the public.

Finally, DOS has introduced legislation that would enable it to directly regulate structural steel operations that involve exposure to lead. Such a law would authorize the department to license contractors, require a prescribed training course, and otherwise assure safe working conditions.

House painting

Registry findings indicate that house painting in Massachusetts can pose a serious lead hazard. Approximately 18% of workers with elevated blood lead levels in the Registry were house painters. Even so, the number of house painters reported to the Registry is likely a substantial undercount of the true number of house painters with elevated blood levels, in part because requirements for regular blood lead monitoring were not in place until 1993. It also appears that OSHA does not inspect a large number of house painting operations to enforce the new Lead Standard in Construction. The small size of most house painting firms, combined with the short-term nature of most house painting jobs, requires new prevention strategies to reach workers and employers in this industry with information regarding methods to reduce lead exposure and the importance of regular blood lead tests.

Manufacturing

Although the OSHA Lead Standard has been in place for 15 years for manufacturing workers, overexposure to lead remains a significant problem. Of workers with blood lead levels of 40 mcg/dl or greater, 23% (127 workers) were employed in manufacturing industries, most notably foundries, smelters, plastics, and glass products. Worksite visits by DOS industrial hygienists revealed a variety of conditions contributing to the elevated blood lead levels reported from these employers. Increased enforcement, technical assistance, and education are necessary to address the ongoing problems of overexposure in lead-using manufacturing industries.

Monitoring, notification and training

Interviews with workers who had elevated blood lead levels revealed a number of concerns. Forty-five percent of non-construction workers interviewed reported that they did not receive training about the hazards of lead, and 29% reported that their employer had not provided blood lead monitoring. This is despite the fact that both training and monitoring are required by OSHA and should be expected as a matter of good practice. Bridge and house painters reported even lower rates of training and monitoring, underscoring the need for the strict enforcement of the Lead Standard recently promulgated by OSHA. In contrast, essentially all deleadings interviewed indicated that they had received training and regular blood lead monitoring. This likely reflects the impact of Massachusetts regulations making the licensure of deleading contractors contingent upon compliance in these areas.

A significant number of workers reported that they had not been notified of their elevated blood lead levels either directly by their physicians or by their employers, as required under the OSHA Lead Standards when participating in an employer-sponsored blood lead monitoring program.

Hispanic workers

Hispanic workers are disproportionately represented in the Registry, underscoring the need to provide linguistically and culturally appropriate health and safety services and education programs, and to better understand the employment patterns which place Hispanic workers at increased risk. Overrepresentation of Hispanic workers has also been reported by lead registries in other states, including California, Texas, and New Jersey, and is consistent with evidence that minority workers generally are disproportionately represented in high-risk job categories.

Non-occupational exposures

While the great majority of elevated blood lead levels were occupational in origin, 15 % of registrants with levels above 40 mcg/dl were exposed through non-occupational activities. Firing ranges and home renovation were the most commonly identified sources. Exposure at firing ranges occurs due to the fumes and dust generated in the course of firing lead bullets, and can be controlled with use of jacketed ammunition and proper ventilation and housekeeping practices. Elevated blood lead levels due to home renovation activity underscore the widespread extent of lead in homes in the Commonwealth and the potential for exposure even in projects which are not specifically undertaken for the purpose of deleading. Persons participating in these and other non-occupational activities (e.g. crafts) with potential for exposure to lead need to be informed about the risks involved both to themselves and other family members, as well as about methods of preventing overexposure. The Department of Public Health and the Division of Occupational Safety have initiated programs in this area, including publication of a pamphlet mailed to 8000 physicians, that alerts health care providers to the dangers of adult exposure to lead. In addition, DOS produced a set of posters on lead poisoning and displayed several hundred of them in public buses in several metropolitan areas. Recent publication by the U.S. EPA of booklets on the dangers of lead paint in home renovation is also a step in this direction. However, dissemination of these and similar publications on a wider scale is essential.

Limitations

The most significant limitation of the data in this report is that a large, but unknown, percentage of employees who work in industries known to have high lead exposures do not have their blood lead levels tested. In California, studies have found that less than 10% of employers who use lead conduct routine blood lead testing of their lead-exposed employees.⁵ A few examples from Massachusetts will illustrate the problem. A count of auto radiator repair shops in the phone books for Boston, Springfield and Worcester alone yields a total of 76 companies, yet over the 5 year period of this report only 6 radiator shops were reported to the Registry. The "County Business Patterns," issued by the US Department of Commerce (1992) shows a total of nearly 800 painting companies (with one or more employees), while over 5 years only 64 firms (many of which had no employees) appeared in the Registry. While some of these companies may not appear in the Lead Registry because they do not have lead exposure, or because their employees' blood lead levels do not exceed 40 mcg/dl, it is highly unlikely that these factors alone could account for the large proportion of companies that are absent from the Registry. Although the data reflect a decline in the numbers of persons and new cases reported to the Registry each year, without more complete testing, it is not possible to draw the conclusion that the risk for lead poisoning among Massachusetts workers is declining. Despite these limitations, the Registry continues to identify more than 35 new companies per year where employees are at risk for lead poisoning and where intervention is warranted.

The other serious limitation in the interpretation of the data is that the Lead Registry does not receive all blood lead reports (and does not obtain industry information for blood lead levels below 40 mcg/dl). Without such information the Registry cannot determine the distribution of blood lead levels, neither among workers who are tested as a whole, nor by industry. Without complete laboratory reporting, the Lead Registry is also unable to fully monitor the blood lead levels of individual workers or employers and thus evaluate compliance with the blood lead testing requirements of the OSHA lead standards.

Conclusion

The Massachusetts Occupational Lead Registry, despite its limitations, provides valuable information about occupational lead poisoning in the Commonwealth. Although information is far from complete, it is clear that many industries in Massachusetts expose their workers to high levels of lead and that compliance with the OSHA lead standards is poor. Although, construction workers comprise the majority of registrants in the Lead Registry, other industries are also clearly a problem.

Lack of compliance with other key portions of the OSHA lead standards is also apparent. Apart from deleaders, many workers report that they had received no training on lead hazards or that their employer did not maintain a blood lead testing program.

The Division of Occupational Safety, through its inspectional and educational programs, is working to address many of the problems identified in this report. However, over-exposure to lead on the job will continue to be a significant problem for many Massachusetts workers for years to come. Industry, labor, the medical community, and government each have a role to play

in the effort to control and ultimately prevail over this age-old problem. The Occupational Lead Registry will continue to play an essential role in this effort by generating the information necessary to target and evaluate prevention efforts.

NOTES

1. See 454 CMR 23.00

2. NIOSH Case Definition

A case is defined by NIOSH as an individual with a reported blood lead level greater than 25 mcg/dl for whom there were no reports of elevated blood lead levels during the previous calendar year. This definition accounts for the individual who may be removed from exposure, experience a decline in their blood lead level, and subsequently be re-exposed thereby appearing in the Registry again as a new case. The use of this case definition is an attempt to measure the **incidence** of lead poisoning over time. However, because blood lead levels below 25 mcg/dl are not factored into the case definition, it is not possible to determine whether an individual who drops out of the Registry in a given year, did so because of a reduced blood lead level or because he was not tested. Furthermore, while focus on new cases is important, it should not obscure those individuals who remain in the Registry with elevated blood lead levels year after year (**prevalence.**)

3. Brody D.J., et. al. Blood Lead Levels in the U.S. Population: Phase 1 of the third National Health and Nutrition Examination Survey (NHANES III, 1988 to 1991.) *JAMA* 1994; 272:277-283.

4. Rabin R., Brooks DR, and Davis, LK. Elevated Blood Lead Levels Among Construction Workers in the Massachusetts Occupational Lead Registry. *American Journal of Public Health*, September, 1994; 84(9): 1483-1485.

5. Occupational Lead Poisoning Prevention Program, California Department of Health Services. Blood Lead Levels in California Workers 1993-1994: Report of the California Occupational Blood Lead Registry. September, 1997.

APPENDICES

Appendix A

Federal, State, and Local Lead Information Resources

Appendix B

Educational Materials Available from the Massachusetts Lead Registry

Appendix C

Detailed Tables

APPENDIX A

Federal, State, and Local Lead Information Resources

Government workplace health and safety agencies

Massachusetts Department of Labor and Workforce Development, Division of Occupational Safety has two programs which are responsible for workplace health and safety:

Occupational Hygiene Program (OHP) inspects workplaces and evaluates health hazards, makes recommendations to improve working conditions, and answers questions about workplace hazards such as lead. Calls by employees are handled confidentially.

OHP office: Newton (617) 969-7177

Asbestos and Lead Program enforces deleading and asbestos regulations.

Asbestos/Lead offices:	Boston	(800) 425-0004 (617) 727-7047
	Springfield	(413) 781-2676
	Haverhill	(978) 372-9797
	New Bedford	(508) 984-7718
	Pittsfield	(413) 448-8748

U.S. Occupational Safety and Health Administration (OSHA) inspects workplaces in response to complaints and enforces federal health and safety laws and standards in the private sector.

OSHA area offices:	Methuen	(617) 565-8110
	Braintree	(617) 565-6924
	Springfield	(413) 785-0123

Employers who want assistance coming into compliance with OSHA standards should call the OSHA 7-C-1 Program at (617) 969-7177 for a free consultation.

Blood lead testing and medical referral

SENSOR Program, Massachusetts Department of Public Health (617-624-5632) has a list of occupational health clinics in Massachusetts.

Occupational and Environmental Reproductive Hazards Center, University of Massachusetts Medical Center, Worcester (508-856-6164) provides confidential patient consultations regarding the effects of lead and other toxic exposures on male and female fertility, pregnancy and breastfeeding.

Childhood Lead Poisoning Prevention Program, Massachusetts Department of Public Health

(617-753-8400 or 800-532-9571) answers questions about lead poisoning in children and when children should be tested. It also has a list of clinics that provide free lead testing in children.

Workers' Compensation

Massachusetts Department of Industrial Accidents (DIA) (public information toll free number 800-323-3249) administers the workers' compensation law and answers questions about how the workers' compensation law works. Upon request, it will send a pamphlet explaining how to apply for workers' compensation benefits.

Discrimination

Massachusetts Commission Against Discrimination (MCAD) and U.S. Equal Employment Opportunity Commission (EEOC) handle complaints concerning discrimination and pregnancy disability at the workplace as well as cases concerning workplace exclusionary policies.

MCAD offices:	Boston	(617) 727-3990
	Springfield	(413) 739-2145
	TTY	(617) 720-6054

EEOC offices:	Toll-free number (publications)	(800) 669-3362
	Greater Boston	(617) 565-3200
	TDD number	(617) 565-3204

Worker health and safety training, technical and legal assistance

Coalitions for Occupational Safety and Health (COSH) are non-profit organizations of workers, unions, health and safety experts and labor lawyers. They provide a variety of services, including training, referrals for medical and legal assistance, health and safety fact sheets in English and Spanish, and assistance in setting up health and safety committees.

MassCOSH	(617) 524-6686
Western MassCOSH	(413) 731-0760

Employer assistance

Steel Structures Painting Council provides educational materials and sponsors conferences for employers on painting and paint removal.

Office: 40 24th Street Pittsburgh, PA 15222 (412) 281-2331

Painting and Decorating Contractors of America (617-698-2896) provides seminars on lead abatement for painting contractors.

APPENDIX B
Educational Materials Available from
the Massachusetts Lead Registry

Lead on the Job: A Guide for Employees (also available in Spanish)

Lead in Industry: A Guide for Employers

Lead in Construction (also available in Greek and Spanish)

Where Family Members Can Get Blood Tests for Lead Exposure (also available in Spanish)

Firing Ranges Employer's Guide (by the Texas Department of Health)

Firing Ranges Shooter's Guide (by the Texas Department of Health)

Operations & Maintenance for Buildings with Lead-Based Paint

Medical Guidelines: The Lead Exposed Worker

Medical Evaluation for Lead Exposure

Model Contract for a Lead Medical Program

To obtain copies of these materials, contact:

Occupational Lead Registry
Asbestos & Lead Program
Division of Occupational Safety
1001 Watertown Street
Newton, MA 02165
(617) 969-7177

APPENDIX C

Detailed Tables

**Table C-1. Distribution of Cases¹ and Reports, by Peak Blood Lead Level (25mcg/dl or greater)
April 1991- December 1995 Massachusetts Occupational Lead Registry**

Blood Lead Level (mcg/dl)	Cases		Reports	
	#	%	#	%
25-39	1920	(74.3%)	4447	(74.2%)
40-49	398	(15.4%)	977	(16.3%)
50-59	143	(5.5%)	334	(5.6%)
60-99	115	(4.5%)	213	(3.6%)
100+	8	(0.3%)	22	(0.4%)
Total	2584	(100%)	5993	(100%)

**Table C-2. Distribution of Cases¹ by Peak Blood Lead Level (25mcg/dl or greater)
April 1991-1995 Massachusetts Occupational Lead Registry**

	Total		Blood Lead Level (mcg/dl)					
			25-39		40-59		60+	
	#	%	#	%	#	%	#	%
Gender*								
Male	2483	96%	1836	96%	531	98%	116	94%
Female	99	4%	82	4%	10	2%	7	6%
Total	2582	100%	1918	100%	541	100%	123	100%
Age**								
15-24	226	10%	162	10%	51	10%	13	11%
25-34	751	32%	562	34%	159	30%	30	25%
35-44	703	30%	496	30%	172	33%	35	29%
45-54	383	17%	271	16%	86	16%	26	21%
55-64	172	7%	124	7%	35	7%	13	11%
65+	79	3%	51	3%	23	4%	5	4%
Total	2314	100%	1666	100%	526	100%	122	100%

(Percentages may not total to 100 due to rounding)

* Excludes 2 cases with missing gender information

** Excludes 270 cases with missing age information

¹ A case is defined as: an individual with a reported blood lead level greater than 25mcg/dl for whom there were no reports of elevated blood lead levels during the previous year.

Table C-3. Comparison of Deleaders, Painters, Other Construction Workers, and Non-Construction Worker with Elevated Blood Lead Levels (40 mcg/dl and greater), by Peak Blood Lead Level and Age* April 1991 - December 1995 Massachusetts Occupational Lead Registry										
	Total		Deleaders		Painters		Other Construction Workers		Non-Construction Workers	
	#	%	#	%	#	%	#	%	#	%
No. of Cases ¹	547	100%	175	100%	161	100%	44	100%	167	100%
Blood Lead Level										
40-59	448**	82%	153	87%	115	71%	32	73%	147	88%
60+	99	18	22	13	46	29	12	27	20	12
Total	547	100%	175	100%	161	100%	44	100%	167	100%
Age***										
15-24	54	10%	14	8%	15	10%	3	7%	22	13%
25-34	165	31%	67	40%	50	32%	12	27%	36	22%
35-44	172	32%	57	34%	53	34%	16	36%	46	28%
45-54	89	17%	20	12%	28	18%	7	16%	34	21%
55-64	37	7%	4	2%	8	5%	4	9%	21	13%
65+	13	2%	4	2%	3	2%	2	5%	4	2%
Total	530	100%	166	100%	157	100%	44	100%	163	100%

(Percentages may not total 100 due to rounding)

*Excludes 117 cases with non-occupational exposures or missing information which could not be matched with an SIC code.

** Includes 1 case with occupational exposure but unknown SIC code

***Excludes 17 cases with missing age information

¹ A case is defined as: an individual with a reported blood lead level greater than 25mcg/dl for whom there were no reports of elevated blood lead levels during the previous year.

Table C-4. Interview Responses of Cases¹ with Elevated Blood Lead Levels (40mcg/dl or greater), by Industry Category. April 1991-December 1995* Massachusetts Occupational Lead Registry

	Total		Deleaders		Painters		Other Construction		Non- Construction	
	#	%	#	%	#	%	#	%	#	%
Cases Interviewed	320	59%	87	50%	104	65%	31	70%	98	59%
Race/Ethnicity										
White	260	84%	74	84%	92	88%	31	100%	67	73%
Hispanic	27	9%	5	6%	6	6%	0	-	5	5%
Black	16	5%	5	6%	4	4%	0	-	18	20%
Other	6	2%	2	2%	3	3%	0	-	1	1%
Asian	3	1%	2	2%	0	-	0	-	1	1%
Total	312	-	88	-	105	-	31	-	92	-
Tested as part of medical monitoring program										
yes	201	63%	84	97%	36	35%	14	44%	67	71%
no	118**	37%	3	3%	67	65%	18	56%	28	29%
Total	319	-	87	-	103	-	32	-	95	-
Learned Results through health care provider or employer										
yes	278	87%	82	89%	91	87%	30	94%	79	83%
no	42	13%	10	11%	14	13%	2	6%	16	17%
Total	320	-	92	-	105	-	32	-	95	-
Co-Workers at risk for exposure										
yes	242	77%	63	72%	73	70%	28	99%	80	84%
no	71	23%	25	28%	31	30%	4	1%	14	14%
unknown	1	-	0	-	0	-	0	-	1	2%
Total	314	-	88	-	104	-	32	-	95	-
Training received in the hazards of lead										
yes	192	62%	83	95%	39	38%	16	52%	54	59%
no	118***	37%	4	5%	64	61%	15	48%	34	37%
unknown	5	2%	0	-	1	1%	0	-	4	4%
Total	315	-	87	-	104	-	31	-	92	-
Child under age of 6 at home										
yes	86	27%	19	21%	33	31%	13	42%	21	21%
no	227	73%	70	79%	72	69%	18	58%	77	79%
Total	313	-	89	-	105	-	31	-	98	-
Household member pregnant										
yes	16	5%	2	2%	10	10%	1	3%	3	3%
no	291	94%	82	95%	94	90%	30	97%	88	97%
unknown	2	1%	2	2%	0	-	0	-	0	-
Total	309	-	86	-	104	-	31	-	91	-
Removed from further exposure to lead for medical reasons (60mcg/dl and greater)										
yes	14	39%	5	50%	3	18%	5	83%	1	33%
no	21	58%	5	50%	13	76%	1	17%	2	67%
unknown	1	3%	0	-	1	6%	0	-	0	-
Total	36	-	10	-	17	-	6	-	3	-

*Number of responses to individual items do not necessarily sum to total number of interviews because responses were not obtained from all individuals for each item. Percentages may not total 100 due to rounding. Percentage interviewed based on 547 cases, 175 deleaders, 161 painters, 44 other construction workers, and 167 non-construction workers.

** Includes 2 cases without SIC information.

*** Includes 1 case without SIC information.

¹ A case is defined as: an individual with a reported blood lead level greater than 25mcg/dl for whom there were no reports of elevated blood lead levels during the previous year.

**Table C-5. Numbers of Cases¹ (40 mcg/dl or higher) by Year, Industry.
April 1991-December 1995 Massachusetts Occupational Lead Registry**

	1991	1992	1993	1994	1995	Total
Deleaders	62	38	13	33	29	175
Other Construction	48	28	36	47	46	205
Non-Construction	66	22	43	22	14	167
No Industry Information Available	22	29	27	25	14	117
Total	198	117	119	127	103	664

**Table C-6. Number of reports of elevated blood lead levels (BLLs) among adults, number of adults with elevated BLLs, and number of new cases¹ of elevated BLLs (25 mcg/dl and greater).
April 1991-December 1995 Massachusetts Occupational Lead Registry**

	1991			1992			1993		
Highest BLL (mcg/dl)	No. Reports	No. Persons	No. Cases	No. Reports	No. Persons	No. New Cases	No. Reports	No. Persons	No. New Cases
25-39	694	435	435	997	587	420	947	574	373
40-59	259	161	161	285	161	98	274	161	98
60+	59	37	37	37	28	19	48	28	21
Total	1012	633	633	1319	776	537	1269	763	492
	1994			1995					
Highest BLL (mcg/dl)	No. Reports	No. Persons	No. Cases	No. Reports	No. Persons	No. New Cases			
25-39	930	567	382	878	486	310			
40-59	239	159	103	254	135	81			
60+	42	30	24	49	26	22			
Total	1211	756	509	1181	647	413			

Table C-7. Number of new workplaces identified each year for cases¹ with blood lead levels greater than or equal to 40mcg/dl, April 1991- December 1995 Massachusetts Occupational Lead Registry

Year	No. of New Workplaces Identified
1991	93
1992	39
1993	39
1994	51
1995	40
Total	262

¹ A case is defined as: an individual with a reported blood lead level greater than 25mcg/dl for whom there were no reports of elevated blood lead levels during the previous year.

